Capital Infrastructure Renewal Forecasting (CIRF)

September 30, 2004

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CIRF discussion topics

- Introduction: CIRF as a Tool for Life-Cycle Management

- CIRF Case Study: Elmendorf, AFB Logistics Facilities

- Technical Detail

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CIRF defined

▸ "A predictive life-cycle approach to long-term capital asset planning that can be used to restore physical assets to a desired level of condition over time and align assets with an organization's mission and goals."

CIRF basis

‣ Detailed architectural-engineering condition assessments are useful tools, but...
- Costly and resource intensive
- Short-lived
- Typically only account for existing deficiencies (no out-year recapitalization)

‣ Booz Allen Hamilton conceptualized and designed CIRF to provide large infrastructure owners with an affordable and expedient alternative for baseline condition assessments, asset inventory management, and short- and long-term project planning

‣ CIRF creates the ability to direct resources where they're most needed and to manage the life-cycle of every asset

‣ The CIRF concept was borne out of industry (IBM, Walt Disney, Host Marriott) and higher education institutions

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CIRF analysis integrates life-cycle concepts to evaluate the total cost of owning and sustaining an asset portfolio…

‣ Creates an accurate asset inventory with manageable pieces of information about every asset

‣ Valuates the inventory with industry-accepted cost estimating references

‣ Assigns mission "importance" metrics adapted from other organizations and industry

‣ Validates and/or determines extent of maintenance backlog and recapitalization needs

‣ Uses "expected design life" approach—validated by facility users—for asset subsystem replacement strategies

‣ Provides short- and long-term funding scenarios required to sustain a portfolio over time at acceptable levels of condition through the use of industry-accepted metrics

‣ Highlights the need to be diligent about disposal strategies
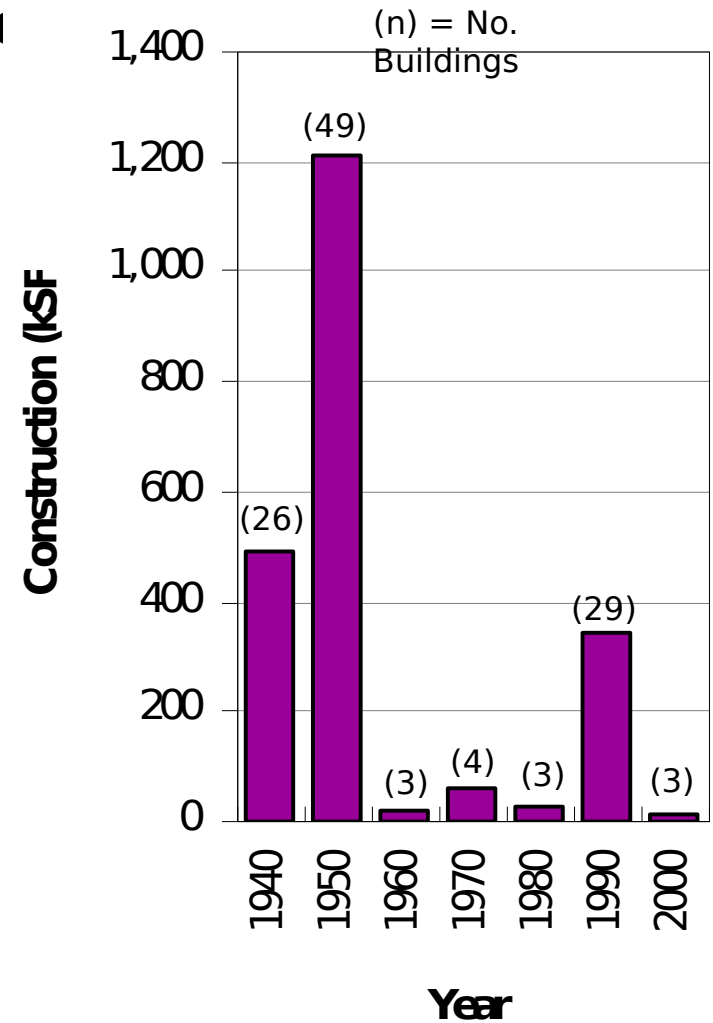
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Recent CIRF outcomes

▸ In a pilot conducted for PACAF/LG logistics facilities at Elmendorf AFB, CIRF provided the LG organization with a mechanism for boosting their planned budget to $14M in new projects over 5 years (that's 28% of the project total for the base—LG is typically 9% of the total budget)

▸ Other organizations have doubled their project funding and execution by providing rigorous business case analysis to the CFO and authorizing/appropriating communities

▸ The Department of Interior and Environmental Protection Agency are implementing CIRF strategies

▸ NASA and the State Department are exploring CIRF

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CIRF discussion topics

‣ Introduction: CIRF as a Tool for Life-Cycle Management

‣ **CIRF Case Study: Elmendorf, AFB Logistics Facilities**
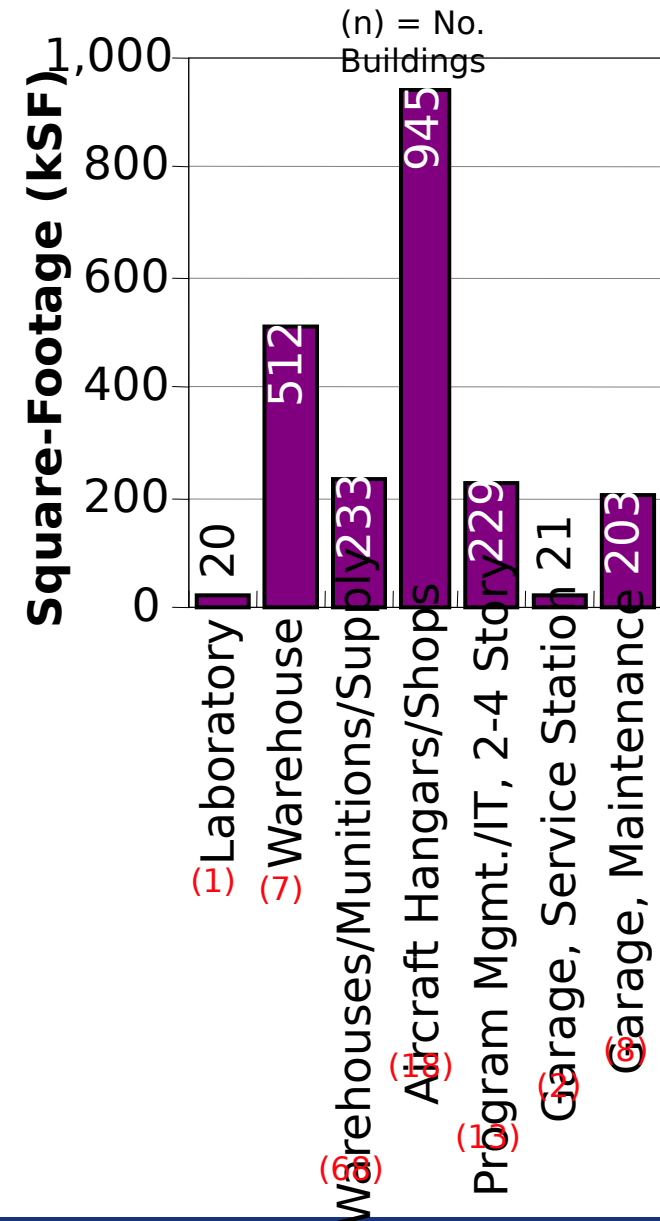
‣ Technical Detail

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About Elmendorf's facility portfolio

‣ Elmendorf Air Field was established in 1940

‣ The Air Force took ownership of Elmendorf in 1951

‣ Booz Allen assessed 117 facilities including over 2.1 million square feet

‣ Approximately 80 percent of facilities assessed were constructed in the 1940s and 1950s

Bar chart titled "Construction (kSF)" vs "Year" with (n) = No. Buildings: 1940 (26) ~490, 1950 (49) ~1,210, 1960 (3) ~20, 1970 (4) ~60, 1980 (3) ~30, 1990 (29) ~340, 2000 (3) ~15

Elmendorf's portfolio

▸ Aircraft hangars and warehouses account for approximately 80 percent of assessed square footage

▸ Facilities that were NOT assessed:
- Square footage less than 1000 SF each
- Slated for demolition AND no longer in use
- Not maintained by Elmendorf MXG, LRS, CONS organizations
- Occupancy of facility less than 50 percent

(n) = No. Buildings

Square-Footage (kSF)

Category	Value
Laboratory (1)	20
Warehouse (7)	512
Warehouses/Munitions/Supply (66)	233
Aircraft Hangars/Shops (12)	945
Program Mgmt./IT, 2-4 Story (10)	229
Garage, Service Station (4)	21
Garage, Maintenance (9)	203

CIRF methodology required a cooperative effort between
PACAF HQ, Elmendorf facility managers, and the Booz Allen team
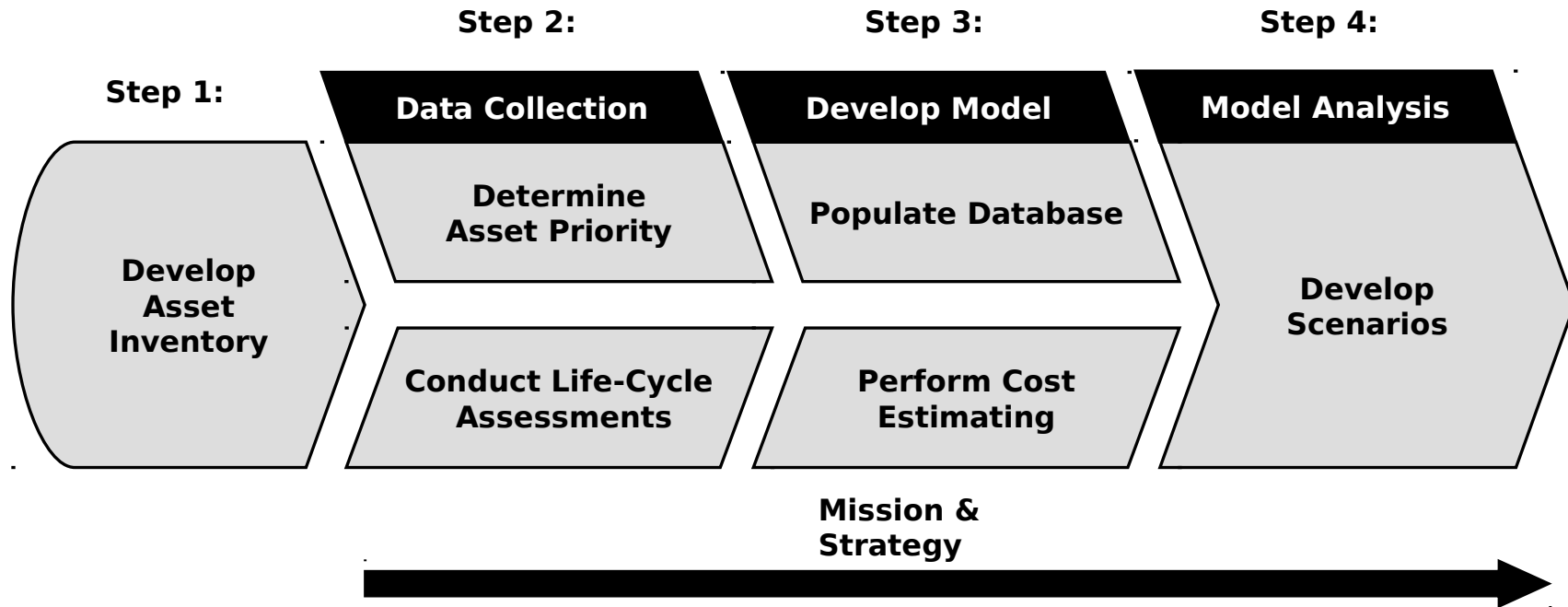
Developed asset inventory
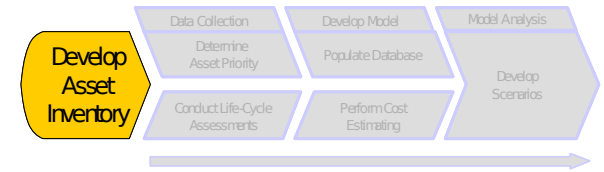
▸ Briefed Elmendorf group and squadron commanders

▸ Met with Civil Engineer Squadron representatives

▸ Met with Office of Real Property

▸ Determined data availability and gathered preliminary data
  - Real property files
  - ACES
  - Locally maintained databases

▸ Initiated asset priority index (API) analysis with Elmendorf squadron commanders

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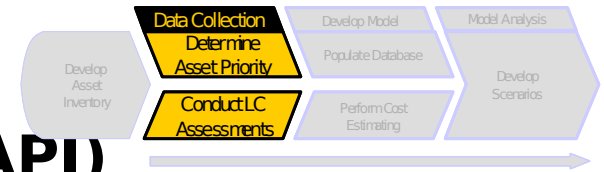
Implemented the asset priority index (API)

▶ The asset priority index (API) is critical to the Capital Infrastructure Renewal Forecasting (CIRF) process. By establishing how a facility fits into an organization's mission and long-term goals, CIRF analysts are able to identify those facilities that require immediate remediation.

▶ An API survey was completed by each Squadron Commander for buildings under their operational responsibility.

▶ API was approved by the Group Commanders.

▶ The primary API score for a given facility is determined by the following two factors:

- Interruptabilty
- Relocatability

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Conducted life cycle assessments (LCA)
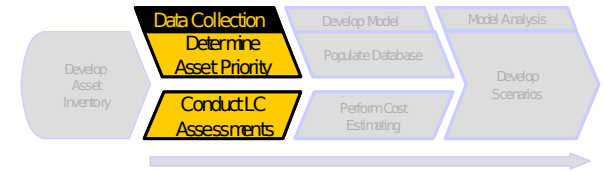
▶ Conducted two Elmendorf site visits

▶ Performed life-cycle assessments

▶ Toured 80 percent of facilities with facility managers

▶ Conducted additional interviews

▶ Finalized API results with Group Commander
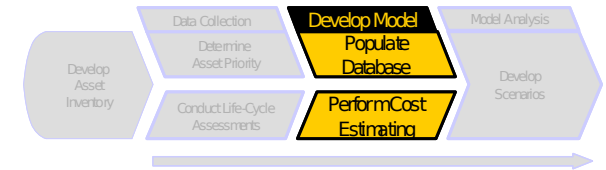
▶ Reviewed data collected with HQ PACAF

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Develop Asset Inventory

Data Collection
Determine Asset Priority
Conduct LC Assessments

Develop Model
Populate Database
Perform Cost Estimating

Model Analysis
Develop Scenarios

LCAs

‣ Elmendorf facilities assessed using life-cycle assessments

‣ LCA defined: an analytical process for determining asset subsystem replacement needs based on expected design life

‣ LCAs are less resource intensive

‣ LCAs are a highly credible and defensible industry accepted method for conducting assessments

‣ LCAs add a vital dimension to the assessment process: the ability to forecast and estimate predicted projects, thus establishing a recapitalization program

‣ LCAs are critical to long-term asset sustainment and stewardship concepts

Developed model

▸ Estimated renewal and deficiency costs using industry accepted RS Means cost estimating data

▸ Validated original assumptions with Elmendorf personnel

▸ Obtained design life data not available in RS Means from manufacturers

▸ Reconciled any data deficiencies

▸ Ran Capital Infrastructure Renewal Forecasting (CIRF) Model

▸ Calculated Current Replacement Values (CRV)

▸ Determined Facility Condition Index (FCI)

▸ Prioritized maintenance and recapitalization projects

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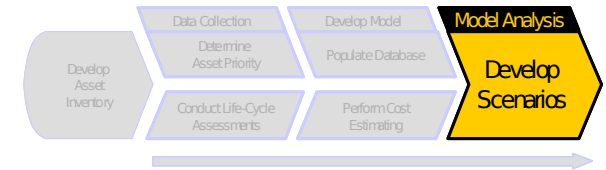
Model analysis

▸ Developed optimal backlog management strategy

▸ Created future funding scenarios

▸ Reviewed impacts of scenarios on short-term and long-term asset condition

▸ Terms

- Current Replacement Value (CRV) — the cost of replacing an asset given its current function and scope
- Component Renewal (CR) — the replacement of a sub-system during the year in which it has reached the end of its expected design life
- Deferred Maintenance – backlog; the replacement of a sub-system that reached the end of its expected design life in a previous year
- Facility Condition Index (FCI) — measure of an asset's condition based on its current replacement value using the following formula:

$$FCI = \frac{Component\ Renewal\ (CR)\ + Deferred\ Maintenance}{CRV}$$

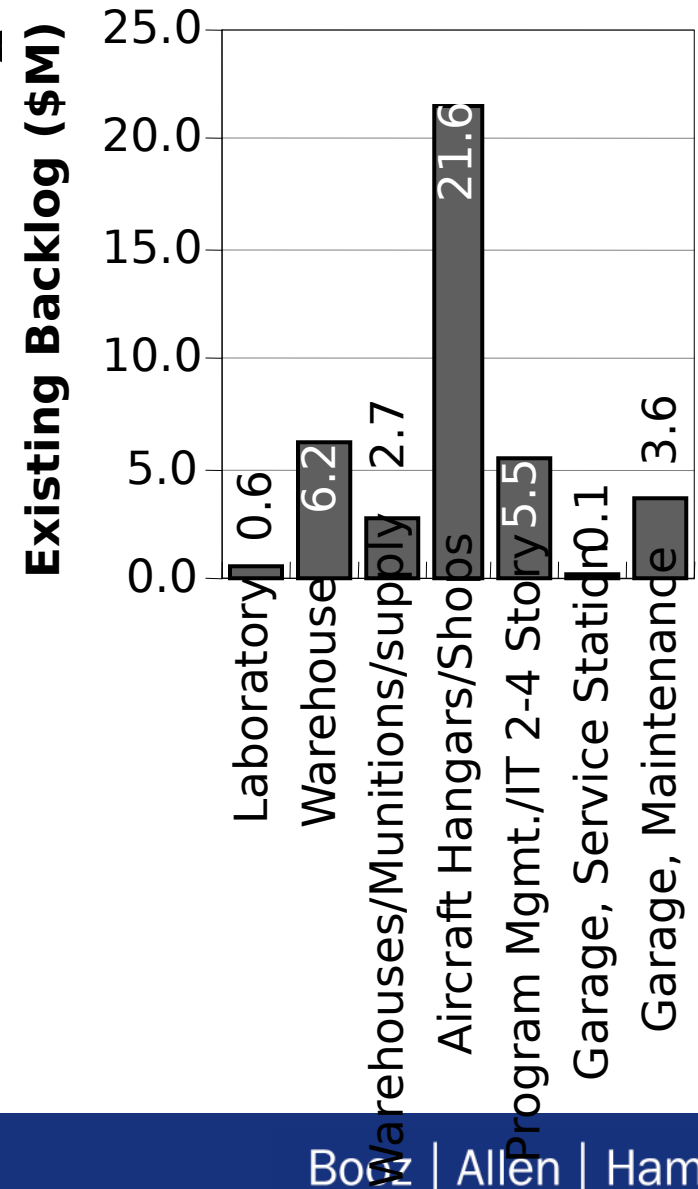Booz | Allen | Hamilton

API score results

▸ Eight facilities, accounting for approximately 209,000 SF, received a ***critical*** score

▸ Most aircraft hangars received a ***moderate*** score

▸ Most warehouses received a ***serious*** score

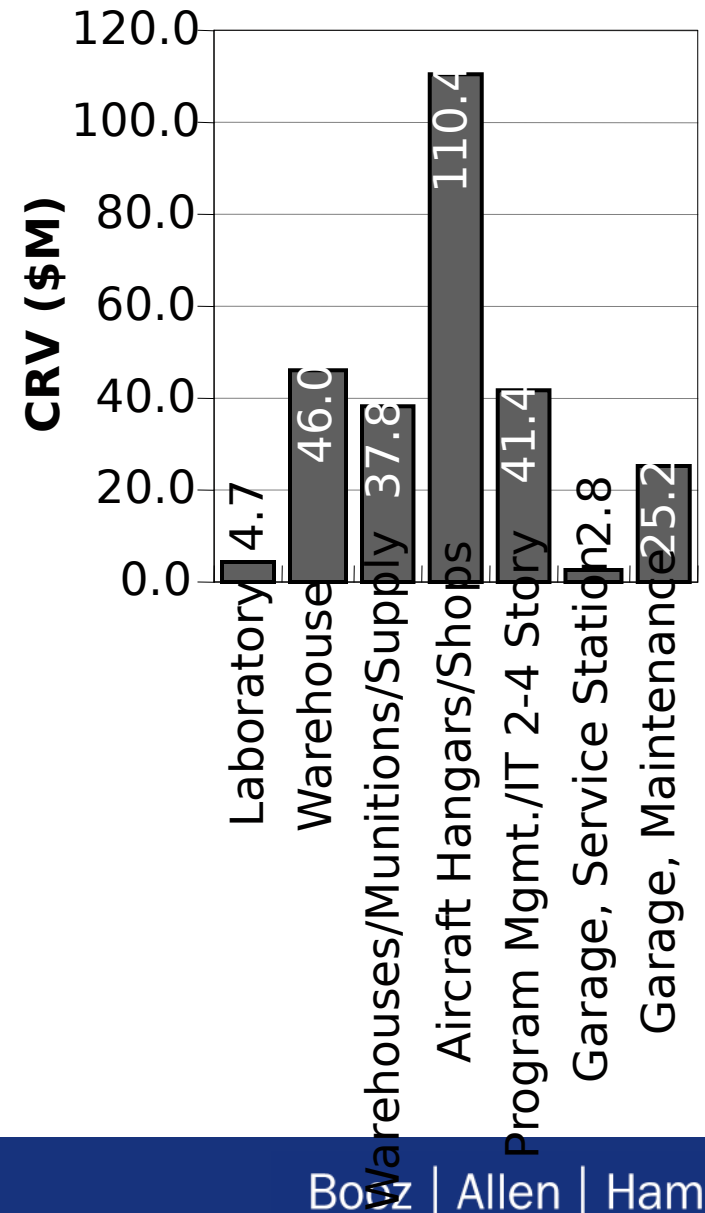| Facility Type	Critical kSF(n)	Serious kSF(n)	Moderate kSF(n)	Minor kSF(n)	Negligible kSF(n)
Laboratory	20(1)	0(0)	0(0)	0(0)	0(0)
Warehouse	0(0)	376(3)	121(3)	15(1)	0(0)
Warehouse (Small)	14(2)	73(27)	77(23)	37(6)	33(10)
Aircraft Hangar	169(4)	50(1)	626(10)	57(2)	43(1)
Office, 2-4 Story	0(0)	6(1)	9(1)	201(7)	13(4)
Garage, Service Station	0(0)	0(0)	21(2)	0(0)	0(0)
Garage, Maintenance	6(1)	35(3)	162(4)	0(0)	0(0)
Total	**209(8)**	**540(35)**	**1,016(43)**	**310(16)**	**88(15)**
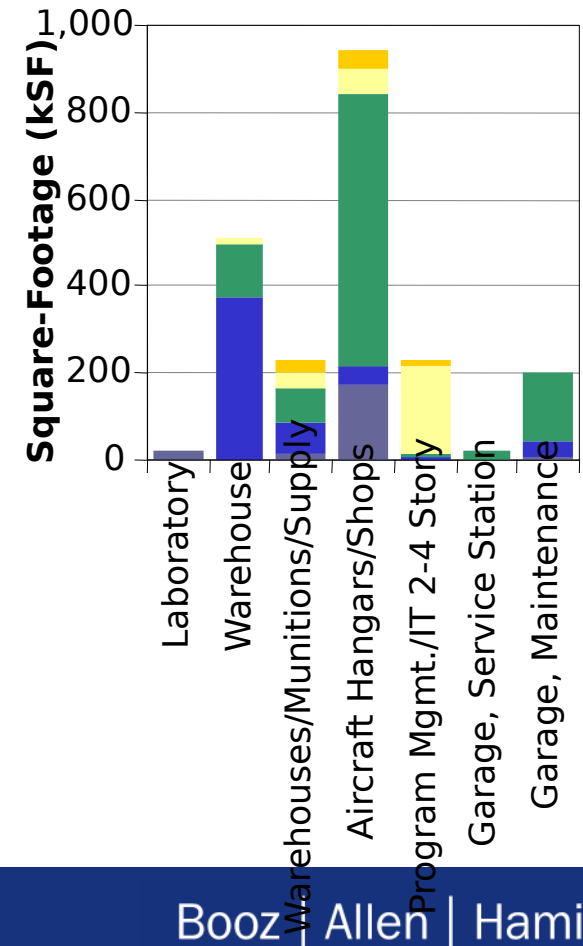
Backlog by facility type at Elmend[orf]

▸ Program management/IT facilities and the laboratory have the highest backlog per square foot because electrical distribution requirements are very high for these types of facilities.

▸ **The total backlog is $40.4 million**

Existing Backlog ($M)

Facility	Backlog
Laboratory	0.6
Warehouse	6.2
Warehouses/Munitions/supply	2.7
Aircraft Hangars/Shops	21.6
Program Mgmt./IT 2-4 Story	5.5
Garage, Service Station	0.1
Garage, Maintenance	3.6

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CRV by facility type at Elmendorf

▸ The table illustrates the estimated total cost to replace Elmendorf LG facilities by type

▸ The square-foot costs to build each facility type were obtained from R.S. Means

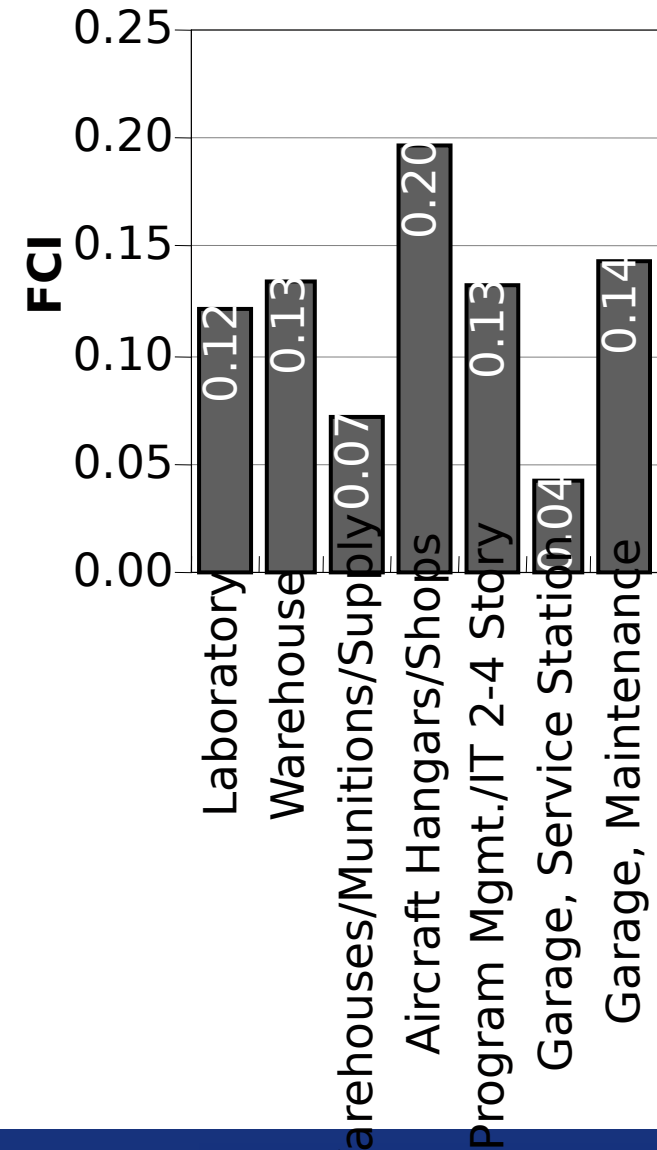▸ **The total CRV for Elmendorf LG facilities is $268 million**

Bar chart — CRV ($M) by facility type: Laboratory 4.7, Warehouse 46.0, Warehouses/Munitions/Supply 37.8, Aircraft Hangars/Shops 110.4, Program Mgmt./IT 2-4 Story 41.4, Garage, Service Station 2.8, Garage, Maintenance 25.2

FCI by facility type

▸ Aircraft hangars generally require the most recapitalization

▸ Facility Condition Index (FCI) — measure of an asset's condition based on its current replacement value using the following formula:

$$FCI = \frac{Component\ Renewal(CR) + Deferred\ Maintenance}{CRV}$$

▸ **Elmendorf's baseline FCI is 15%** ($40M/ $268M)

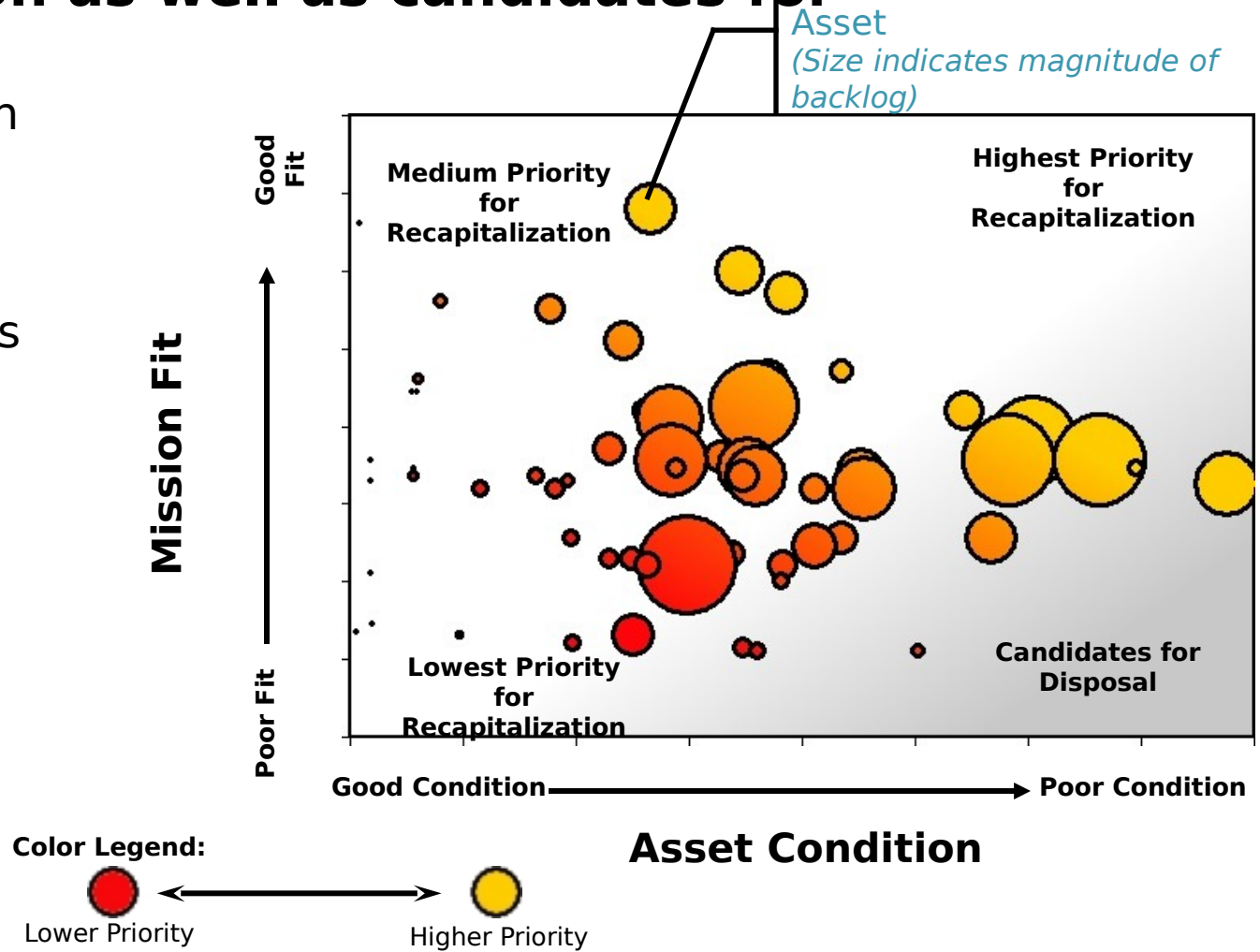Bar chart titled FCI:
- Laboratory: 0.12
- Warehouse: 0.13
- Warehouses/Munitions/Supply: 0.07
- Aircraft Hangars/Shops: 0.20
- Program Mgmt./IT 2-4 Story: 0.13
- Garage, Service Station: 0.04
- Garage, Maintenance: 0.14

Backlog by sub-system category

▸ Electrical deficiencies constitute the greatest portion of backlog

▸ HVAC deficiencies are lower than national averages because

- Alaskan climate doesn't require the installation of air conditioning – typically a large part of HVAC costs.

- The base is primarily serviced by central steam. As a result there are very few boilers throughout the base.

Bar chart titled "Current Backlog ($M)" with categories: Roof 2.3, Exterior 6.4, Conveyance 0.4, Plumbing 4.7, Electrical 16.9, Fire 3.5, HVAC 6.2
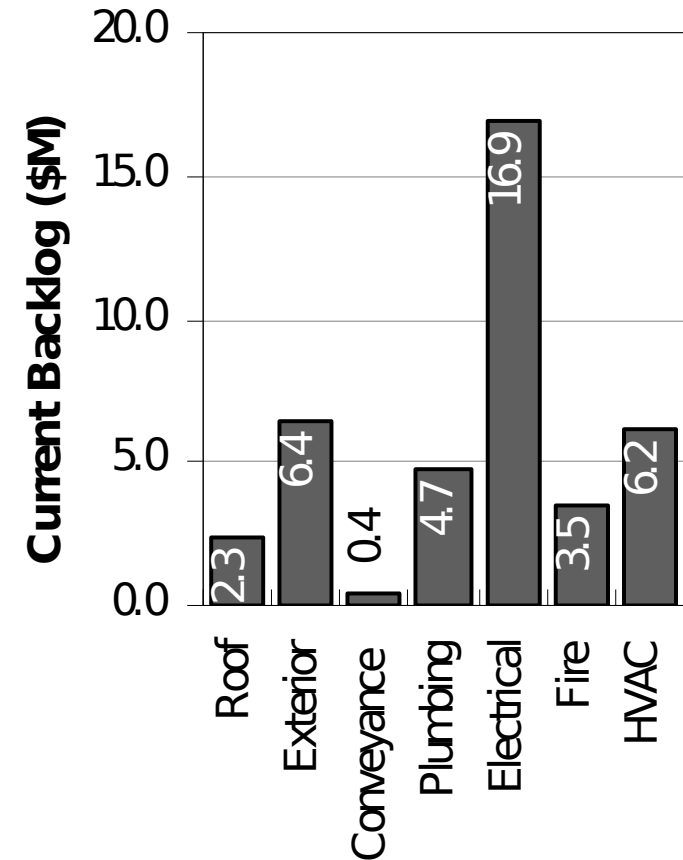
CIRF can drive portfolio strategies, identifying assets with the highest priority for recapitalization as well as candidates for disposal

- ▶ Portfolio segmentation

- ▶ Asset priority index

- ▶ Business case analysis

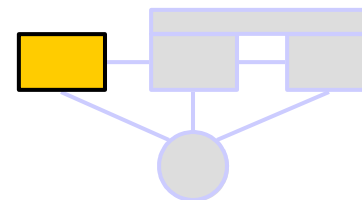- ▶ Review and decision-making framework

- ▶ Property disposal

Asset
(Size indicates magnitude of backlog)

Mission Fit

Good Fit

Poor Fit

Medium Priority for Recapitalization

Highest Priority for Recapitalization

Lowest Priority for Recapitalization

Candidates for Disposal

Good Condition ——→ Poor Condition

Asset Condition

Color Legend:

Lower Priority ←——————→ Higher Priority

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The CIRF profile is comprised of five components. Each component contributes to the forecasted FCI.

- Prioritized spend-down
- Annual new component renewal
- Funding cap
- Annual backlog remediation
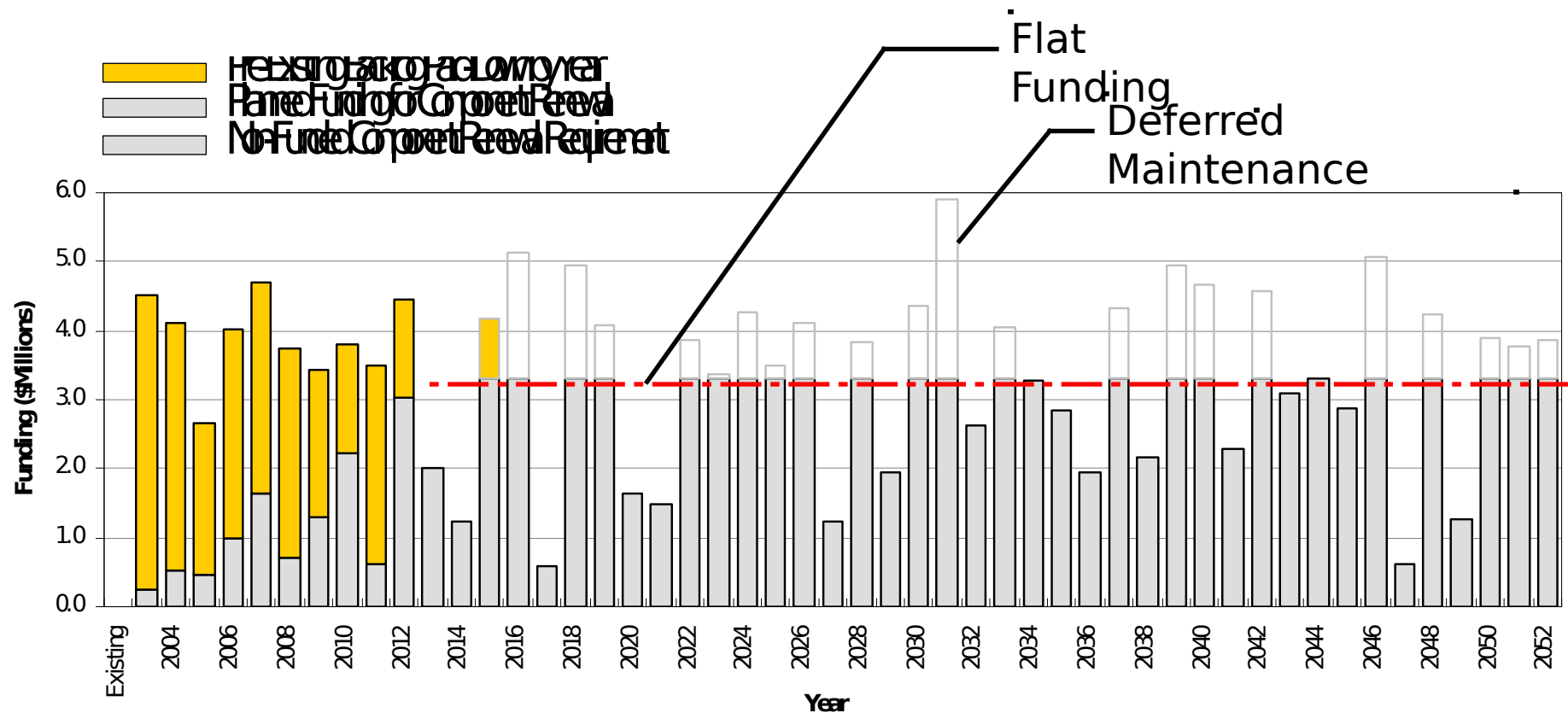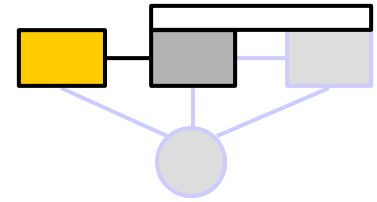- Facility condition index
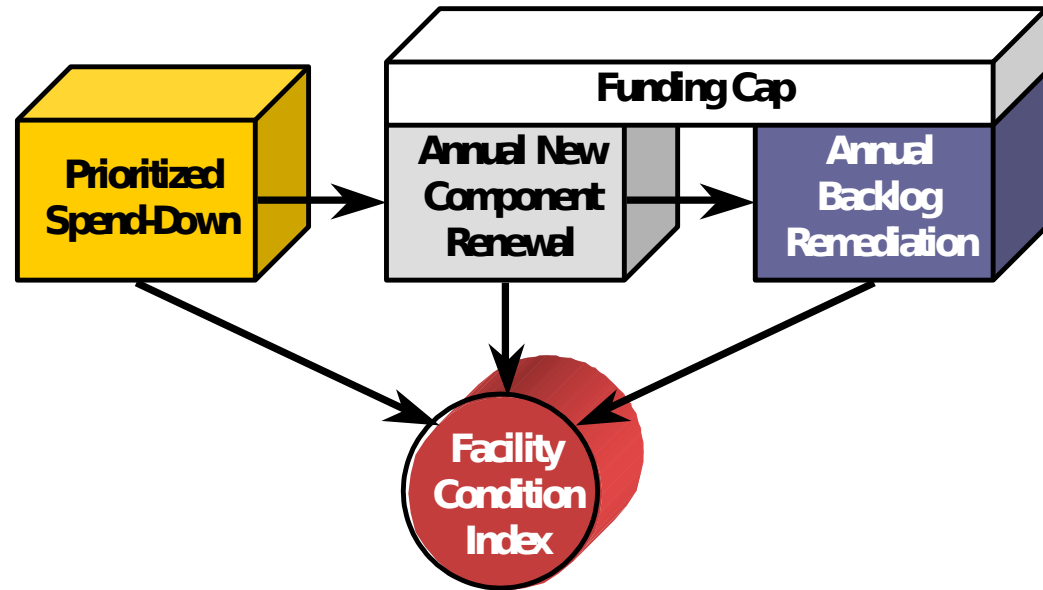
In order to reduce the portfolio FCI from 0.15 to 0.05, two-thirds of the backlog must be eliminated. This can be executed over ten years. While all the backlog is deficient today, we spread project funding over ten years for manageability.
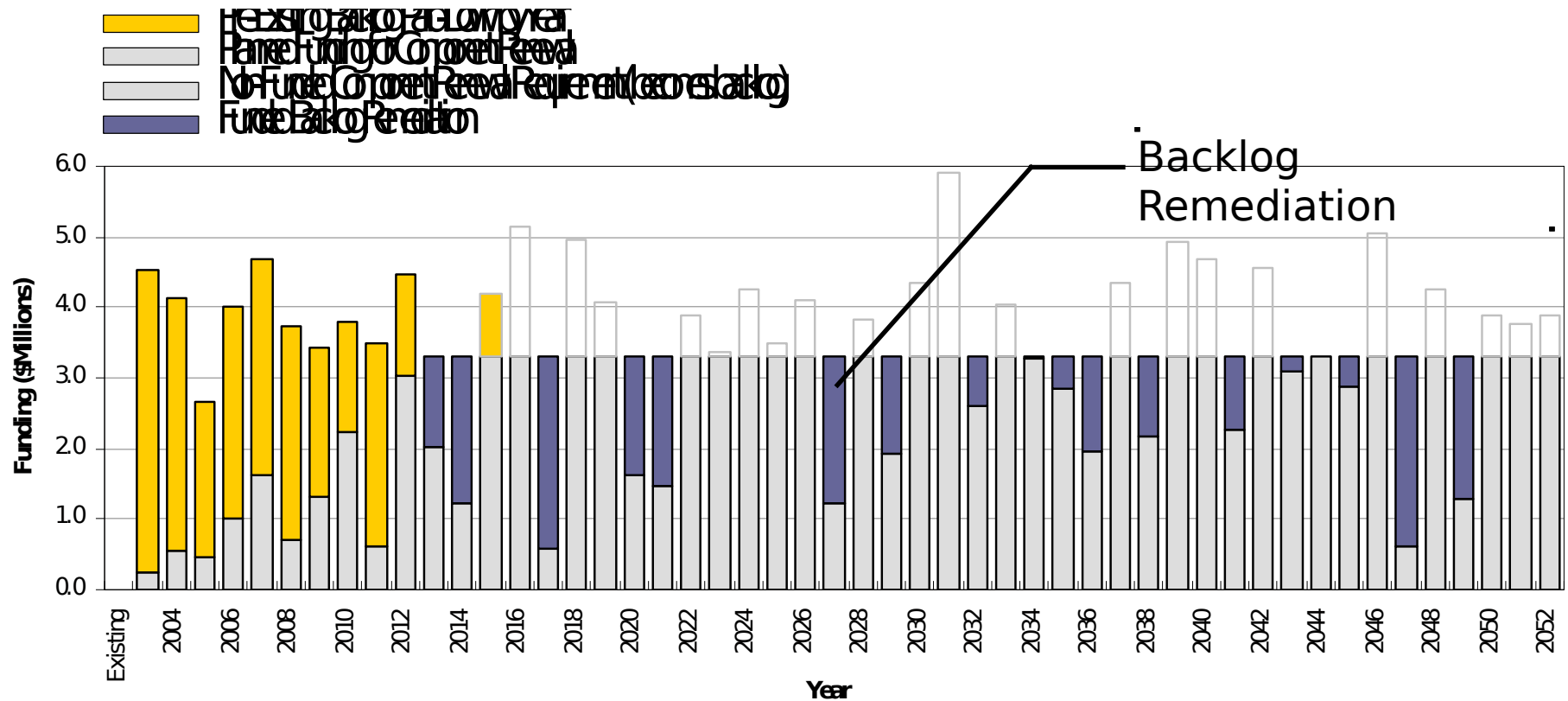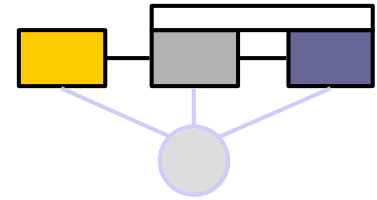
Existing Backlog - Low $/Year

Total 10-Year Backlog Remediation = $27 million

Funding ($Millions)

Year

Existing · 2004 · 2006 · 2008 · 2010 · 2012 · 2014 · 2016 · 2018 · 2020 · 2022 · 2024 · 2026 · 2028 · 2030 · 2032 · 2034 · 2036 · 2038 · 2040 · 2042 · 2044 · 2046 · 2048 · 2050 · 2052

6.0 · 5.0 · 4.0 · 3.0 · 2.0 · 1.0 · 0.0

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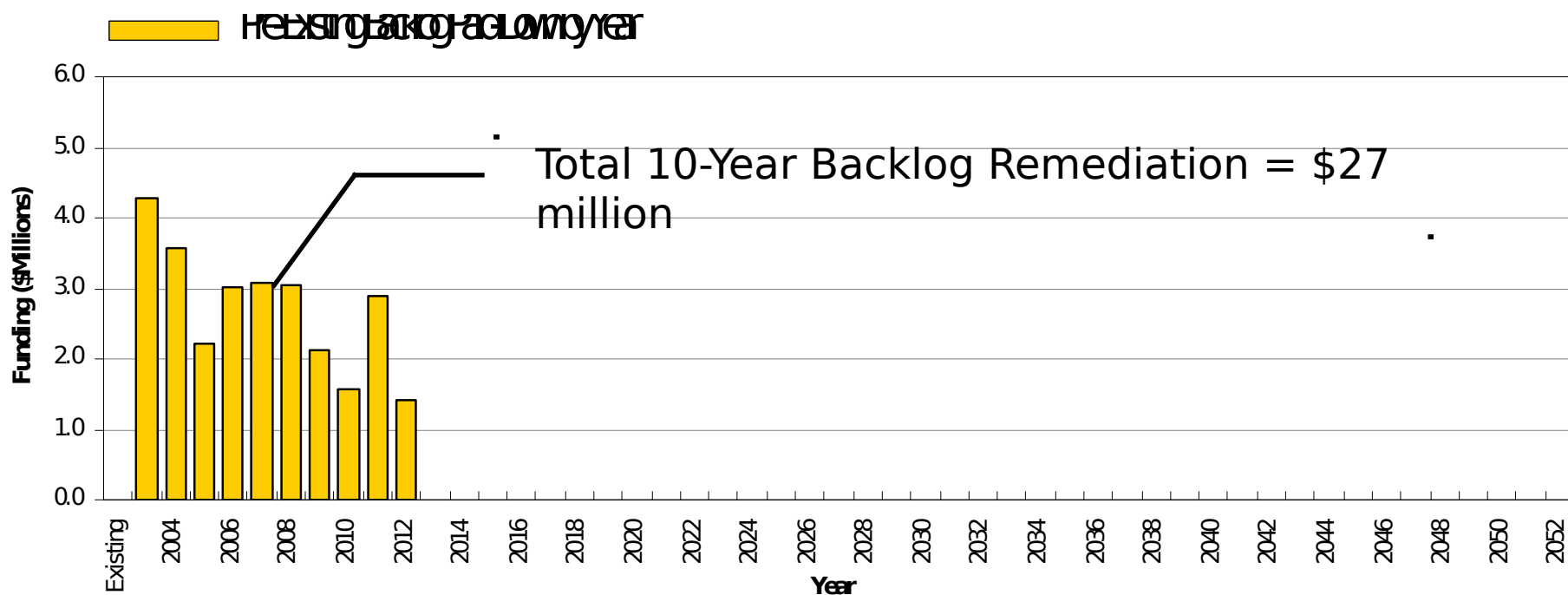
In addition to reducing backlog, new components expire annually. This does not include base O&M funding.
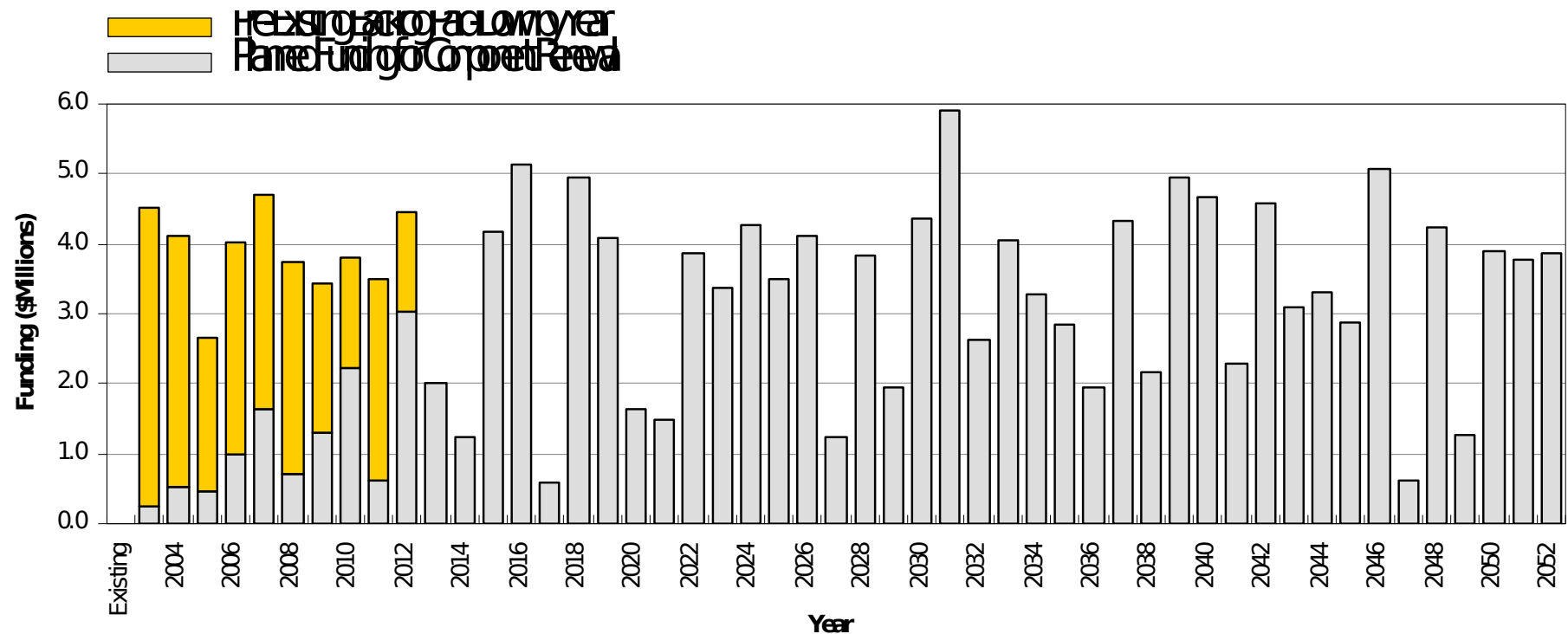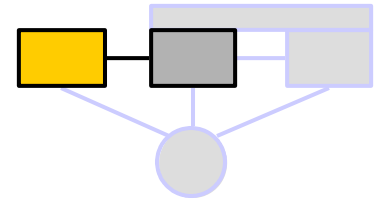
Component renewal that exceeds a flat funding ceiling becomes deferred maintenance or backlog.
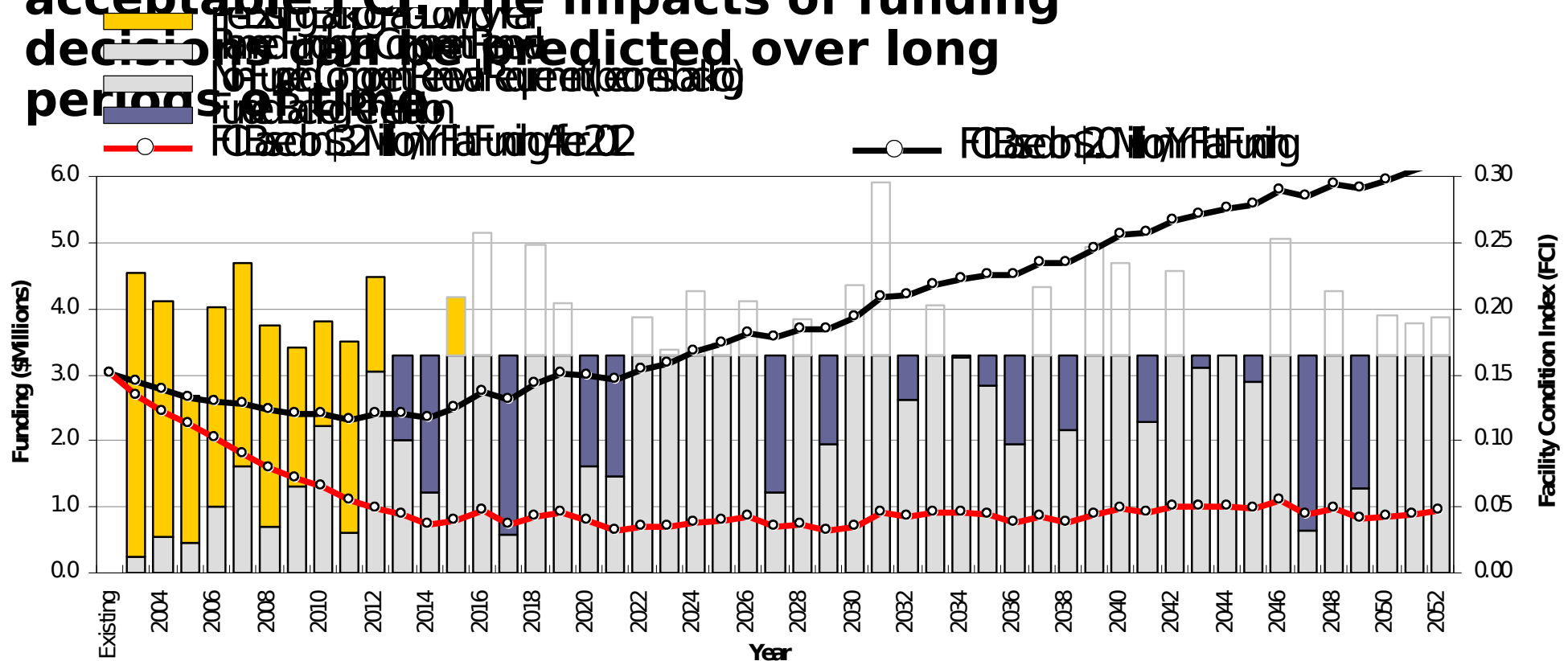

Funding ($Millions) (y-axis: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0)

Year (x-axis: Existing, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052)

Legend:
- Flat Funding
- Deferred Maintenance

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Backlog can be reduced in years when component renewal is less than the funding ceiling by taking advantage of component renewal spikes.

Backlog Remediation

Legend:
- Existing Backlog at Low year
- Planned Funding of Component Renewal
- No Funded Component Renewal Replacement (becomes backlog)
- Funded Backlog Remediation

Y-axis: Funding ($Millions) — 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0

X-axis: Year — Existing, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052

The CIRF model combines all five components to show the necessary funding to maintain the portfolio at an acceptable FCI. The impacts of funding decisions can be predicted over long periods of time.

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The planned backlog remediation and component renewal costs for FY2003 through FY20012 are the aggregation of specific sub-system replacements.

FY2005 Backlog Remediation

FY2005 Component Renewal

Unique Recapitalization Project

CIRF discussion topics

‣ Introduction: CIRF as a Tool for Life-Cycle Management

‣ CIRF Case Study: Elmendorf, AFB Logistics Facilities

‣ **Technical Detail**

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CIRF model structure

Building ID
Ownership
Year Built
Square-Footage
Roof Area
Height
Frame Type
Exterior Type
Building Use
Perimeter

Facility Database

Cost Database
(Cost/Design Life)

Roof
Exterior
Conveyance
Plumbing
Electrical
Fire Protection
HVAC
Misc.

Scenario Analysis

Time Horizon
Annual Planned Funding
Annual Mediated Backlog
Annual Facility Condition Index (FCI)
Cumulative Backlog
Graphic Representation

Building ID
Sub-System Description
Year of Last Replacement
Quantity
Year(s) to Be Replaced

Sub-System Database

Priority Analysis

Asset Priority Index (API)

Building ID
Interuptability
Relocatability
Environmental Hazards
High Cost Equipment
High Personnel Occupancy
Unique (one of a kind)
Quality of Life
Safety
Historic Preservation
Security

Building ID
Asset Priority Index (API)
Current Replacement Value (CRV)
Facility Condition Index (FCI)
Asset Score/Rank
Priority Rating

Asset inventory

▸ A description of assets that is comprehensive yet minimizes unneeded detail

Year Built
Asset ID

Square-Footage

	Bldg	Owner	Year Built	Floor (SF)	Flrs	Fctr	Roof (SF)	Perimeter	Height	Wall (SF)	Area	Vol (kCF)	Cat Code	Prefix	Building Use	
7	04251	3 LG/LRS	1954	220,693	1.0	1.0	220,693	2,260	35	79,100		0	442-758	442	Warehouse	Bea
8	05253	3 LG/LRS	1985	7,243	1.0	1.0	7,243	340	15	5,106		0	442-257	442	Warehouse (Mini)	Bea
9	05257	3 LG/LRS	1952	137,832	1.0	1.0	137,832	1,485	15	22,275		0	442-758	442	Warehouse	Stee
10	06211	3 LG/LRS	1953	123,024	1.3	1.0	94,634	1,460	25	36,500		0	214-425	214	Garage, Repair	Stee
11	06253	3 LG/CMS	1956	20,296	1.0	1.0	20,296	565	20	11,300		0	218-868	218	Laboratory	Bea
12	06254	3 LG/LRS	1953	8,044	1.0	1.0	8,044	464	15	6,960		0	214-426	214	Warehouse (Mini)	Stee
13	06256	3 LG/LRS	1952	8,044	1.0	1.0	8,044	359	15	5,381		0	214-426	214	Warehouse (Mini)	Steel H
14	06263	3 LG/EMS	1951	25,959	1.0	1.0	25,959	644	30	19,334	25,959	779	211-159	211	Aircraft Hanger	Steel
15	06265	3 LG/EMS	1952	4,250	1.0	1.0	4,250	261	15	3,912		0	211-159	211	Warehouse (Mini)	Steel Fu
16	06266	3 LG/LRS	1956	8,044	1.0	1.0	8,044	464	15	6,960		0	214-426	214	Warehouse (Mini)	Steel F
17	06315	3 LG/EMS	1944	8,915	1.0	1.0	8,915	189	12	2,266		0	218-852	218	Office, 2-4 Story	Steel
18	07228	3 LG/LRS	1952	17,430	1.0	1.0	17,430	568	30	17,040		0	214-467	214	Warehouse	Beari
19	07250	3 LG/LRS	1944	6,101	1.0	1.0	6,101	312	15	4,687		0	610-121	610	Office, 2-4 Story	Steel
20	07309	3 LG/LRS	1944	61,380	1.0	1.0	61,380	1,016	75	76,200	45,880	3,441	171-875	171	Aircraft Hanger	Steel
21	08237	3 LG/EMS	1945	11,520	1.0	1.0	11,520	429	15	6,440	11,520	173	211-152	211	Aircraft Hanger	Cond
22	08286	3 LG/LRS	1952	4,020	1.0	1.0	4,020	276	15	4,140		0	214-425	214	Warehouse (Mini)	Steel
23	08288	3 LG/LRS	1944	32,935	1.0	1.3	42,816	336	38	12,768	32,935	1,252	214-425	214	Aircraft Hanger	Steel
24	08317	3 LG/LRS	1944	6,514	1.0	1.3	8,468	396	20	7,920		0	121-111	121	Office, 2-4 Story	Steel

Cost database

▶ RS Means™ Cost Works™ provides key cost and design life data. This data is combined with manufacturer interviews and other research to develop a custom cost database
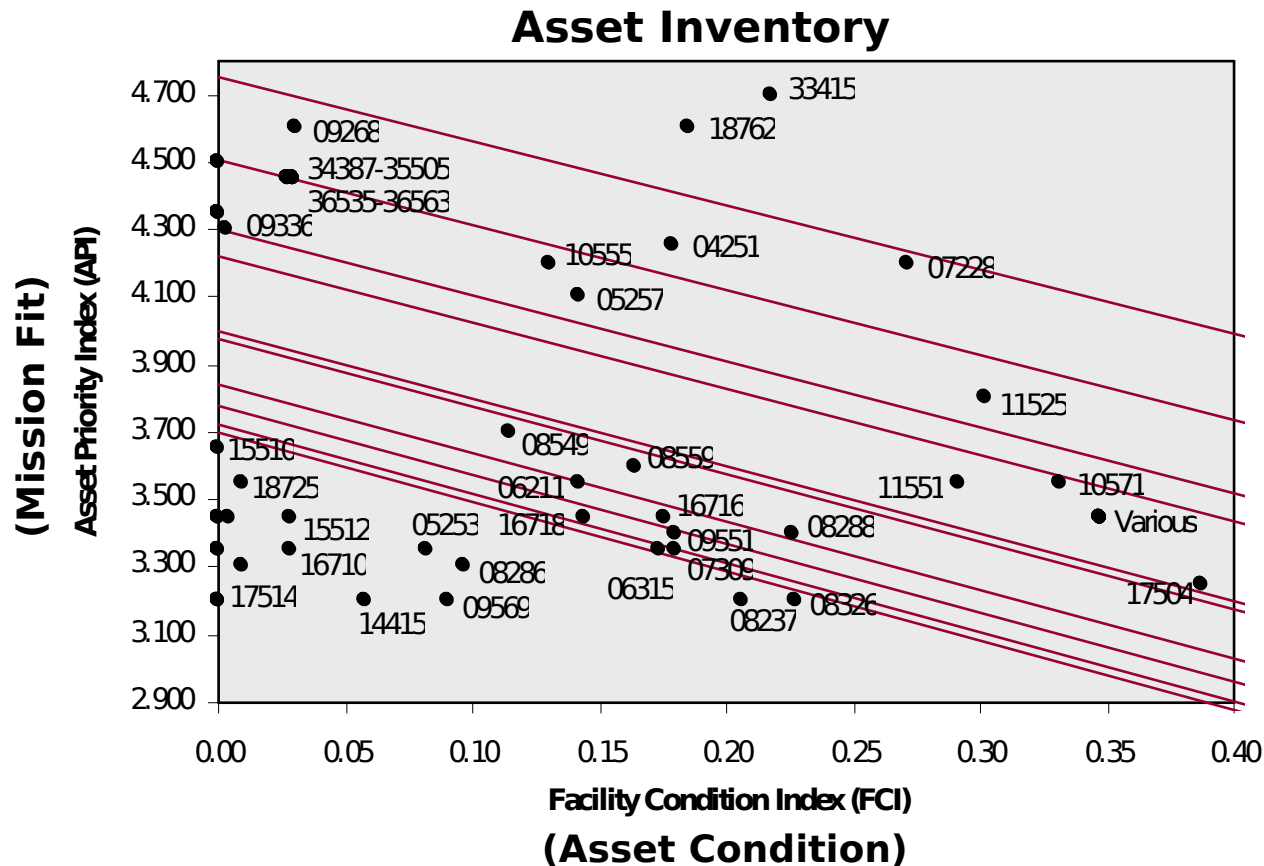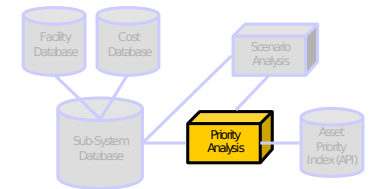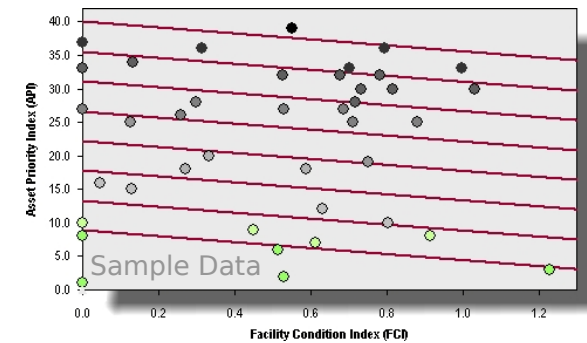
Sub-system database

- Contains an inventory of major infrastructure systems, focusing on manageable pieces

- Develops *cost and schedule* of facility component replacement using year of last replacement, expected design life, and industry benchmark cost data

Using *Mission Fit* and *Asset Condition*, CIRF prioritizes assets for recapitalization

Asset Inventory

(Mission Fit)
Asset Priority Index (API)

Facility Condition Index (FCI)

(Asset Condition)

More emphasis on Mission Fit

Sample Data

More emphasis on Asset Condition

Sample Data

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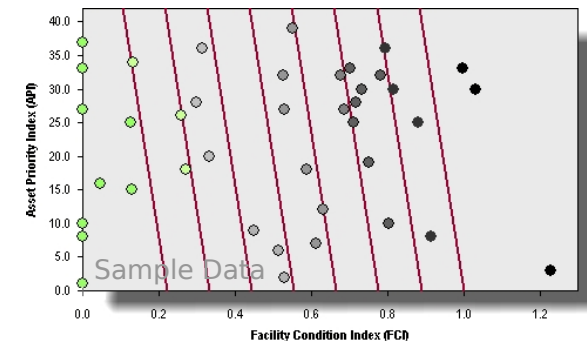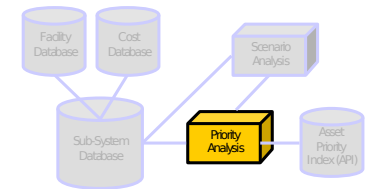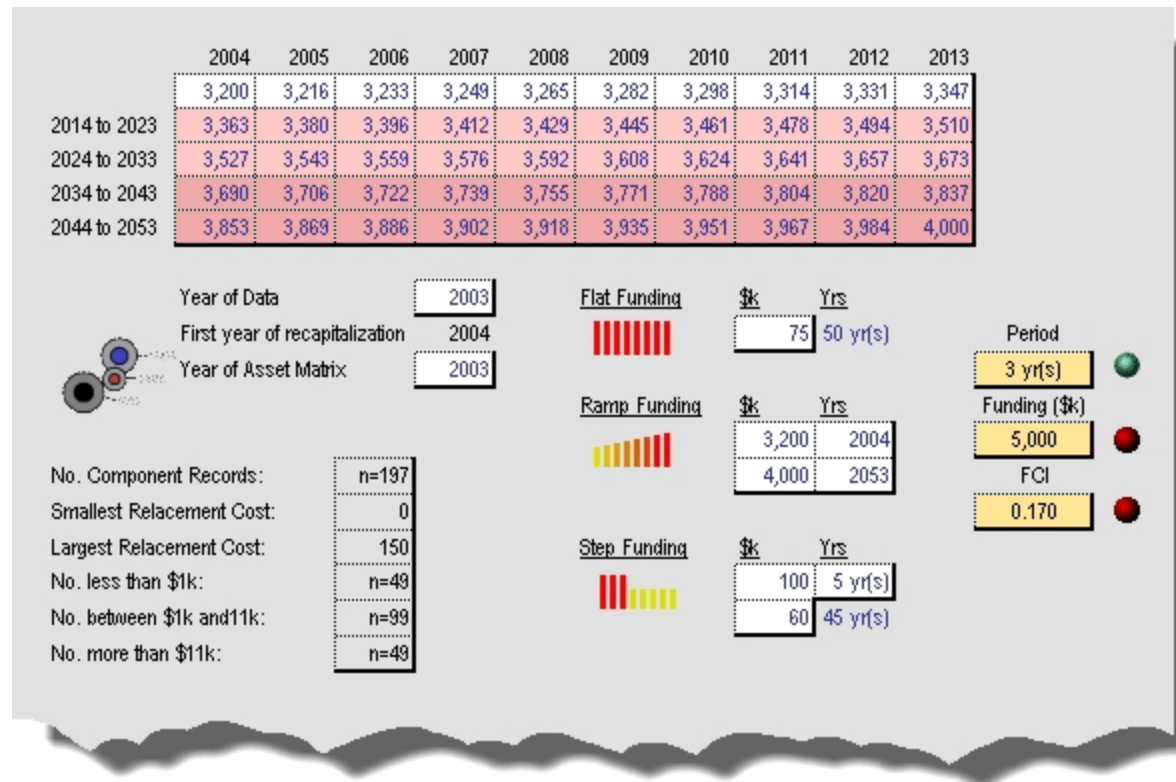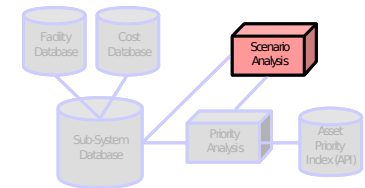
Priority analysis

▸ Every year each asset's score is recalculated to determine its new priority
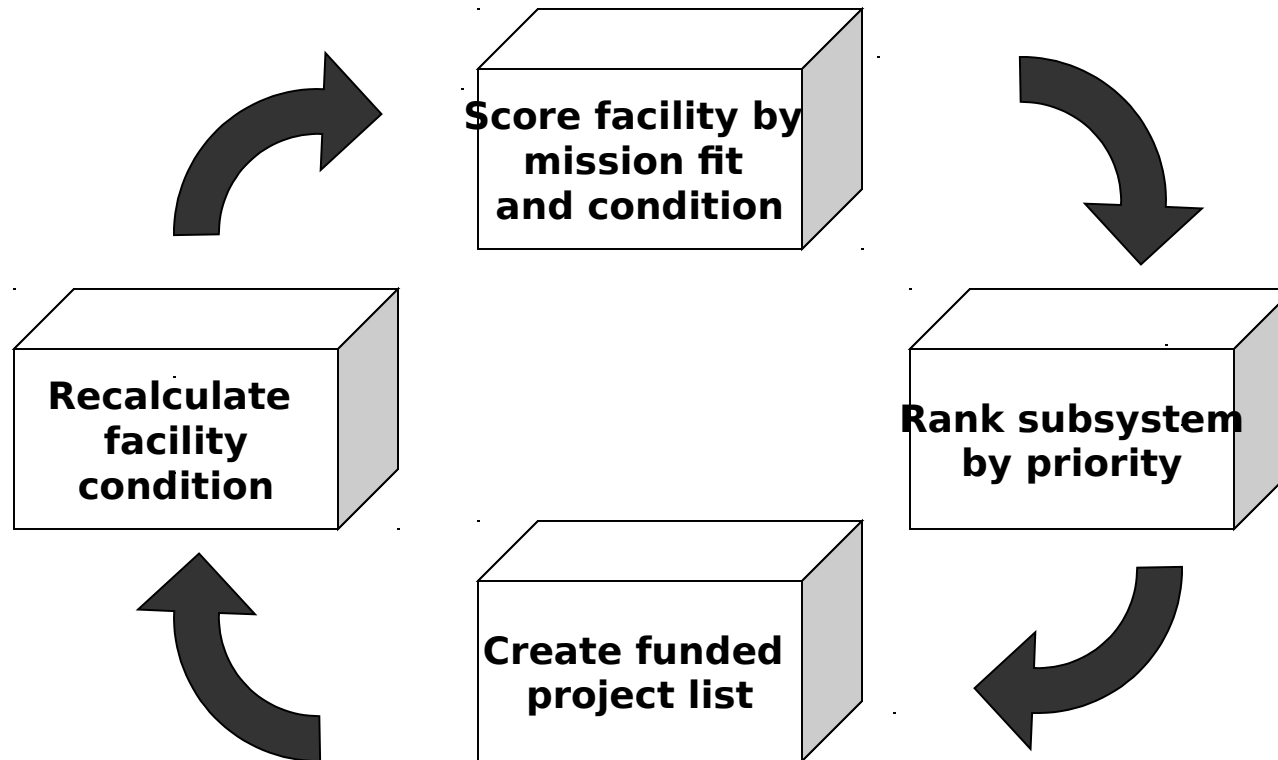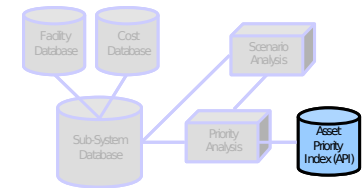
Scenario analysis

▸ Different scenarios can be run by constraining some combination of funding, time, or asset condition
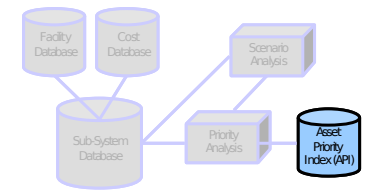
API scoring

- Interruptability is scored from the response to the following question:
  - *How long could the "functions" supported by the facility be stopped without impact on the mission? i.e., allowable down time?*

- Relocatability is scored from the response to the following question:
  - *If the infrastructure required evacuation, could you continue performing your mission by occupying or using another existing facility, or by setting up temporary facilities?*

	Interruptability			
Relocatability	None	Minutes Hours	Days Weeks	Months
Impossible	6	5	4	3
Difficult	6	4	3	2
Possible	6	3	2	1

Key:
Critical + | Critical | Serious | Moderate | Minor | Negligible

API modifiers

‣ Modifiers also are added to part of the API Score

‣ Answering "Yes" to a modifier will add a factor to the API Score

Characteristics	Value	Definition	Examples
Environmental Hazards	0.10	function of the building requires special handling and storage of hazardous materials	Houses oil/water separators and fuel storage
High Cost Equipment	0.10	facility has items such as laboratory equipment, or other specialized communication equipment	Facilities containing computers are not considered High Cost Equipment
High Personnel Occupancy	0.10	facility houses above average numbers of personnel	Administrative and dormitory buildings
Unique (one of a kind)	0.15	facility is the only one of its kind	air traffic control tower
Quality of Life	0.20	facility serves to provide amenities for base staff	Recreational facilities, gymnasiums and housing; NOT administrative space
Safety	0.10	facility requires special maintenance to ensure continued personnel safety	Houses functions involving industrial equipment and explosives
Historic Preservation	0.10	facility is registered or is awaiting registration with a historical society	Historic lodge; on the National Registry
Security	0.15	facility requires a specific level of security beyond entrance to the base	

the aggregation of modifiers = 1.0

Thanks for joining us to learn more about CIRF!

‣ Questions?

‣ Comments?

‣ Suggestions?

‣ For more information:
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